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Rehabilitation Pre and Post MPFL Reconstruction Secondary to MPFL Tear

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Rehabilitation Pre and Post MPFL Reconstruction Secondary to MPFL Tear

by

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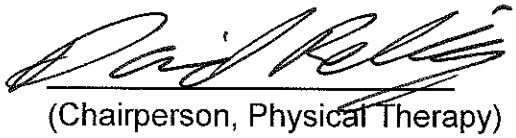
This Scholarly Project, submitted by Kayla Skersick in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Graduate School Advisor)



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Signature Kayla Skesick

Date 10/10/2014

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ABSTRACT

Background and Purpose: The medial patello-femoral ligament (MPFL) is the primary soft tissue structure that withstands forces throughout range of motion (ROM) to prevent the patella from sliding over the lateral femoral condyle and dislocating from the patellar groove.[1,3] Impaired stabilization and line of pull of the patella can directly affect the patella and the entire kinematic chain during movement. MPFL reconstruction has become the most popular surgical treatment to correct this anomaly when conservative strengthening and biomechanical correcting treatments have failed.[1,2,3] This case study evaluates the effectiveness of physical therapy treatment pre-operative and post-operative MPFL reconstruction, and discusses the outcomes experienced by the patient. **Case Description:** The patient was a 36 year old female who received physical therapy treatment before and after MPFL reconstruction surgery. Treatment consisted of 6 pre-op visits and 16 post-op visits, a total of 22 visits. **Interventions:** Physical therapy interventions focused on increasing left knee ROM and quadriceps strength, stability, endurance; improve balance, functional mobility measured by LEFS, and functional activities of the patient. **Outcomes:** Over the course of treatment, the patient's pain was abolished, lower extremity strength equaled 5/5 bilaterally, knee ROM equaled 0-135° bilaterally, functional mobility improved, and she was able to return to caring for her children and completing household tasks safely and independently. **Discussion:** The patient responded well to treatment with all short term and long term goals being met. However, additional research is needed in treating post-MPFL reconstruction to distinguish the best evidence based approach for effective rehabilitation

CHAPTER I

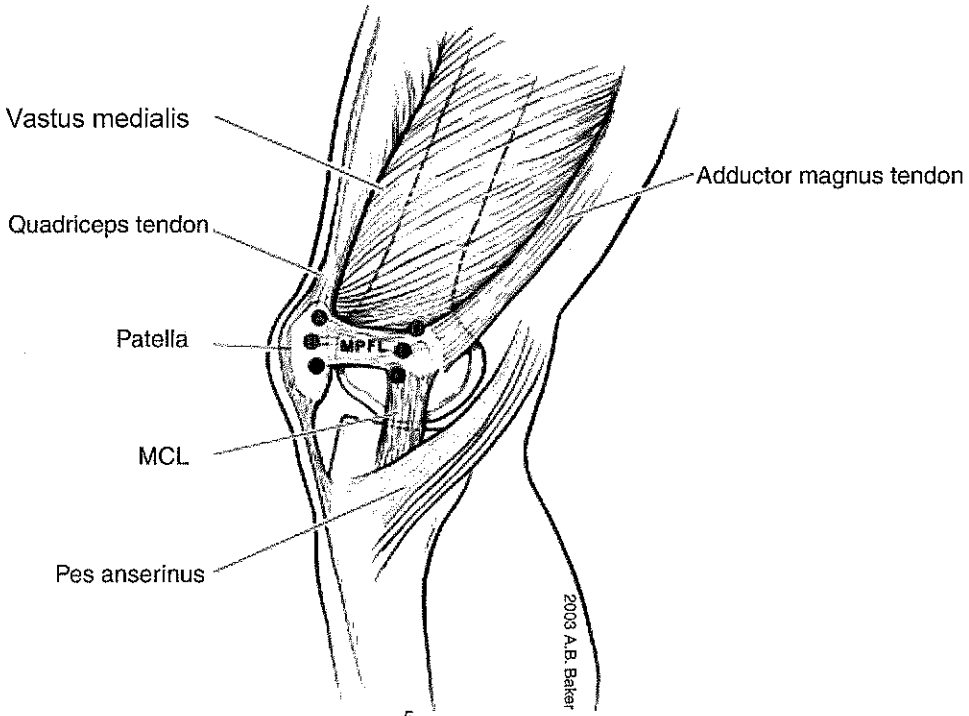
BACKGROUND AND PURPOSE

The medial patello-femoral ligament (MPFL) is the primary soft tissue structure that withstands forces during range of motion that prevents the patella from sliding over the lateral femoral condyle and dislocating from the patellar groove, providing stability to the knee joint.[1]

The MPFL is a distinct condensation of capsular fibers in the coronal plane that originates at the adductor tubercle of the medical epicondyle and adductor tendon, as well as the medial collateral ligament (MCL).[2] The deep fascia and aponeurotic edge of the vastus medialis oblique (VMO) fuses with the superior border of the MPFL.[1,2] The MPFL runs transversely and deep to the distal VMO inserting on the superior-medial aspect of the patella. (See Figure 1). Of the three anatomical layers of the knee, the MPFL is found in the middle or second layer which also includes the para-patellar retinaculum and superficial fibers of the MCL.[1,2,3] With this origin and insertion, the MPFL aids in resisting lateral migration of the patella, providing 50-80% of the restraining force to lateral patellar dislocation.[1,3] Elliott et al[3] reviewed several studies that investigated the medial force and stability of the knee, concluding that the MPFL provides the most force in patellar stability of the soft tissue structures medially. Hautamaa et al[4] used 17 frozen cadaver knee specimens to sequentially section off different

parts of the medial soft-tissue stabilizers in the knee joint. The MPFL, which Hautamaa et al[4] identified in every specimen, was found to be the major static restraint. Isolated release of the MPFL resulted in a 50% increase in lateral patellar displacement, and isolated repair restored balanced forces to the patella. The medial patello-meniscal and patello-tibial ligaments were shown to be important secondary stabilizers. Additional release of these ligaments after release of the MPFL resulted in considerably greater lateral patellar displacement.

Figure 1. Medial knee model demonstrating origin and insertion of MPFL. Reprinted from: Baker, A. (2003). MPFL Anatomy and Biomechanical Factors.



American Journal of Sports Medicine.[5] Permission to include this drawing granted by James Bicos, 6/6/2014.

According to a systematic review by Frosch,[6] patellar instability can result from osseous and soft-tissue abnormalities such as trochlear dysplasia, patella

alta, a high tibial tuberosity trochlear groove (TTTG) distance, weakness of the VMO, or a lesion of the medial retinaculum.

Radiographic imaging and evaluation can be helpful in ruling out other causes of knee pain and bony structure abnormalities that may be a predisposing factor for patellar dislocation.[7, 8] Diagnosis of an MPFL tear or injury is made most often with use of magnetic resonance imaging (MRI).[7] Sanders et al[7] examined MRI findings of MPFL injury patterns and investigated with surgical correlation in 14 patients. MRI was found to be 85% sensitive and 75% correct in diagnosing injury patterns in the MPFL. Nomura et al[8] further studied the correlation of MRI findings with open surgical exploration and reported an 81% accuracy rating (21/26 patients were correctly diagnosed). Therefore, using MRI may be an accurate method to detect injury to the MPFL ligament and associated knee pathology after acute patellar dislocation. However, this study notes that future research with a larger number of subjects should be performed to further verify the sensitivity and specificity of MRI in diagnosing MPFL injuries.[9]

According to Bitar et al[10] over the long term, acute patellar dislocations can result in patellar instability with a high recurrence rate (35%) after non-operative treatment. This study compared non-operative treatment with MPFL reconstruction using the patellar tendon, and found that statistical analyses showed that the mean Kujala score, assessing pain and quality of life, was significantly lower in the non-operative group (70.8) at 2 years compared with the mean value of the reconstruction group (88.9, p=.001). The surgical group presented a higher percentage of good/excellent results (71.43%) on the Kujala

score when compared with the non-operative group (25.0%; p=.003). The non-operative group also presented a large number of recurrences and subluxations (7 patients; 35%), whereas no recurrences or subluxations were reported in the surgical group.[10]

Following MPFL reconstructive surgery, the patient can complete a rehabilitation program, per surgeon protocol, with a physical therapist. There is varying use of conservative versus accelerated protocols by physicians, and there is very little evidence supporting one rehabilitation approach over another.

Do patients experience same outcomes and return to function faster with a non-conservative treatment program? The purpose of this case report is to present and compare an aggressive rehabilitation protocol to other protocols available in research in terms of timelines and progressions for weight bearing status, bracing utilized, range of motion restrictions, return to functional activities, crutch use, and when to introduce closed kinetic chain strengthening following MPFL reconstruction.

This report will describe the rehabilitation process of a patient with an MPFL reconstruction from initial evaluation to discharge. In addition, the patient's response to treatment interventions and functional outcomes will be recorded to better understand the current evidence available on an accelerated rehabilitation approach for MPFL reconstruction.

CHAPTER II

CASE DESCRIPTION

Subject History

The patient was a 36 year-old female who was a stay at home mother. Having recently moved she lifted a box and bumped her left knee against a storage box, and subsequently dislocated her left patella on 8/21/2013. She fell onto her right side and reduced the patella herself immediately, but with pain. The following day the patient's husband assisted her to the emergency room and was sent home with crutches. The patient's leg "locked up" in the parking lot leaving the emergency room and she could not walk to her car. She was re-admitted and x-rays were completed which illustrated no bony pathologies. A Magnetic Resonance Image (MRI) test was also completed which revealed an MPFL tear in the left knee. She then consulted an Orthopedist on 8/29/2013 and was scheduled for MPFL reconstruction surgery for 9/16/2013. She was referred for outpatient physical therapy 8/30/2013 for lower extremity strengthening and increasing range of motion (ROM) 2 weeks prior to surgery. The patient attended 6 physical therapy sessions prior to surgery. Pre-surgery physical therapy interventions focused on improving objective measurements. These improvements included: left knee active range of motion (AROM) from 0-98 degrees to equal bilaterally, strength improved from 3+/5 to 4/5 bilaterally, and

Lower Extremity Functional Scale (LEFS) [11] score improved from 17/80 (21.25% of maximal function) to 25/80 (31.25% of maximal function). According to Binkley et al[11], test-retest reliability of the LEFS scores was excellent (r=.94 [95% lower limit confidence interval (CI) =.89]) the LEFS consists 20 items, each with a maximum score of 4. The total possible score of 80 indicates a high functional level. The scale is one page, can be filled out by most patients in less than 2 minutes, and is scored by tallying the responses for all of the items. Scoring is performed without the use of a calculator or computer and requires approximately 20 seconds. Patient was discharged from pre-operative physical therapy five days prior to MPFL reconstruction surgery.

Following MPFL reconstruction, the patient was referred back to outpatient physical therapy for lower extremity strengthening, improving ROM, balance, and gait training. Arthroscopy pictures revealed a bone fragment from the left lateral femoral condyle that had been broken off during the dislocation event. No protocol was provided by surgeon for rehabilitation. The patient was weight bearing as tolerated (WBAT) with restrictions to avoid left knee rotation for 6 weeks. She was given an upright hinged knee brace by her physician in attempt to prevent rotation for 4 weeks, or until patient re-gained neuromuscular control and stability of her knee. She presented to physical therapy with bilateral axillary crutches to comfort her fear of re-injury when ambulating in the community after surgery. Patient had overall fair health, with her medical history including thyroiddysfunction and varicose veins. Her family history was unremarkable with the exception of a father who was diabetic and a mother who had thyroid

dysfunction. Patient had history of chronic patellar dislocations on the right knee followed by transtibial tubercle transfer (TTT) in 2001. No right patellar dislocations had occurred since this surgery. The patient had no history of left lateral patellar dislocations. There was no history of patellar dislocations, joint dysfunction or joint degeneration noted in her family. She lives with her husband and three children in a large two-story house that had all wood flooring with 4 steps to enter, and 8 steps and bilateral railings to both the second level and to the basement. Prior to the injury, she had no difficulty with activities of daily living, ascended and descended stairs, and walked independently with no pain or feelings of instability. Following surgery, her goals were to be able to return to prior function which included: caring for her children, driving, and completing household tasks feeling safe and pain-free.

A systems review was conducted throughout the history and continued into the examination. There were no impediments to the neurological system. There were direct impediments to the integumentary and musculoskeletal systems from the surgery. The integumentary system was affected by the 2 scope incisions roughly 1cm in length superior-lateral and inferior-medial to patella, a 2 inch incision for access to medial patella for drilling, a 1 inch incision near medial femur for drilling and a 1 inch incision over lateral femur to assess and remove the bone fragment. There was visible swelling below patella that was measured objectively in the initial examination. The musculoskeletal system was further assessed during the initial examination post operatively.

Following a thorough review of her medical history, it was concluded that the patient would benefit from physical therapy. Her goals were appropriate for physical therapy and she was motivated to attain them. An examination plan was developed to evaluate the patient's musculoskeletal system following surgery which included ROM, strength, circumference measurements, and mobility observation. Following the examination, an intervention plan was established to address the limitations found during the examination.

Examination

The patient arrived to the initial outpatient visit 1 week post-op, utilizing bilateral axillary crutches wearing a prophylactic knee brace. She was WBAT, with precautions to wear the knee brace in attempt to limit rotation at the left knee for 4 weeks. The brace could be taken off during physical therapy as needed. The axillary crutches as stated by the patient were for her security when ambulating in the community and could discontinue use whenever she felt comfortable ambulating without them. The patient had an antalgic and guarded gait pattern with decreased step length on right, step to on right, and decreased stance phase on left. Her left leg was wrapped with ACE™ wrap from mid calf to mid thigh with bandages and gauze dressing underneath. The patient had been instructed by her physician to remove the ACE™ wrap 3 days post-op to change the bandages. The patient was taking over the counter (OTC) non-steroidal anti-inflammatories (NSAIDs) as needed and utilizing cold pack application for pain. Her pain level was described on a 0-10 numerical scale (0=no pain, 10=most extreme pain). According to a study by Gallasch and Alexandre[12] this scale had

the most reliability (r=0.99) and was easy to understand compared to the verbal rating, face, and visual analog scale. She stated her pain level had been 10/10 with weight bearing and with activities and 0/10 at rest since the surgery.

The patient was unable to walk, lift, twist, bend, negotiate stairs, complete household activities such as cleaning and cooking, don and doff socks/shoes, pick up children's toys up off of the floor, and care for her children (without pain). The patient's husband was transporting her to her physical therapy and physician appointments, due to her ROM limitations. The patient reported previously using axillary crutches following the TTT in 2001 and stated she was comfortable and safe using them on level ground and on stairs. Patient demonstrated satisfactory use of bilateral axillary crutches on level ground and negotiating stairs. The LEFS was administered to the patient upon arrival to the clinic for the initial evaluation post–op for self reporting level of function. According to Cacchioa,[13] the LEFS is reliable for test-retest (r=0.94, 95% lower limit CI=0.89), valid, and responsive to change in determining function and quality of life when compared to the Short Form-36 (SF-36). The patient had an initial visit LEFS score of 17/80 (21.25% of maximal function) post-operatively according to the scoring procedures outlined by Binkley et al.[11]

Knee active range of motion (AROM) goniometric measurements were taken with the patient in long sitting on a plinth with the gauze dressings, ACE™ wrap, and brace removed from her left leg. Goniometry measurements were performed according to Norkin and White.[14] Utilizing a goniometer to measure the angle of the knee joint is both reliable (r=0.98, ICC=0.99) and valid (r=0.97-0.98,

ICC=0.98-0.99).[15] AROM of right knee was extension/flexion 0°-138° and pain-free. AROM of left knee equaled 0-10°-93°, with patient noting sharp pain at 85° flexion. Passive range of motion (PROM) of left knee was equal to AROM with an empty end feel present. Muscle guarding was noted at 70° left knee flexion due to hesitancy from previous crepitus.

Gross muscle testing was performed while the patient was sitting on a plinth. Right lower extremity strength was 4/5 throughout. Left knee flexion and extension were deferred at initial evaluation due to pain and swelling, and post-surgical status; all other left lower extremity strength testing (hip flexion, extension, abduction, adduction, internal rotation, external rotation; ankle plantarflexion, dorsiflexion, inversion, eversion) was 4/5. During palpation, point tenderness was noted along the antero-medial aspect near the medial femoral condyle where the scope incisions were.

Circumference measurements were taken with a tape measure using the mid patella as the center point landmark. The dressings, ACE™ wrap, and knee brace were all removed for circumference measurements. At initial evaluation post-operatively the incisions were healing well with no apparent signs or symptoms of infection. Table 1 displays the initial post-operative examination objective measurements including AROM and PROM, gross muscle testing, pain levels, circumference and LEFS scores. Table 1. Initial Post-Op Examination Knee Objective Measurements

	Right Knee	Left Knee
AROM & PROM	0°-135° pain-free	10°-93° painful Pain starts at 85°
Gross Muscle Test	4/5	Deferred due to pain/swelling/post surg.
Pain Level	0/10 at all times	10/10 with WB & activity 0/10 at rest
Circumference: - 15cm below patella - 1" below patella - Mid patella - 1" above patella	 40 cm 38 cm 42 cm 47 cm	 40 cm 38.5 cm 42 cm 47 cm
Lower Extremity Functional Scale score	17/80	

After obtaining pertinent information in the initial examination, an ablement model was used to identify all of the factors that play a role in the patient's rehabilitation process. The International Classification of Functioning (ICF) model from *The Guide to Physical Therapy Practice*[16], displays how the patient's health condition relates to her limitations/impairments and abilities. It correlated with the positive attitude of the patient, amount of family support and the limitations and abilities she had. All factors of the model were addressed appropriately with the focus of implementing interventions to strengthen, improve ROM, and facilitate return to prior function and activities safely and pain-free. (See appendix A).

Evaluation

Following the examination, a problem list was created and included the following: pain, decreased AROM and PROM, decreased strength, swelling, inability to care for children, inability to complete household activities without pain, LEFS score 17/80, decreased balance and stability, inability to negotiate

stairs. Short and long term goals were formulated to address the patient's problem list noted during the initial evaluation. The goals are listed as follows:

Short Term Goals (to be completed in 1-2 weeks)

Following Physical Therapy Intervention:

1. The patient will have decreased pain with weight bearing from 10/10 to 4/10 or less to allow patient to squat down to pick up her children's toys off the floor.
2. The patient will demonstrate increased AROM from 0-93 degrees to 0-120 degrees in order to negotiating stairs safely and independently without assistive device or railings.
3. The patient will demonstrate improved lower extremity functional scale score to at least 30/80 in order to improve her ability to complete household tasks independently such as cleaning, cooking, and laundry.

Long Term Goals (to be completed in 4-8 weeks)

Following Physical Therapy Intervention:

1. The patient will have decreased pain from 10/10 to 0/10 with weight bearing activities in order to complete household tasks such as cleaning, cooking, and laundry.
2. The patient will demonstrate increased lower extremity strength to at least 4/5 in order to be able to squat down to pick up her 2 year old child safely and without risk for re-injury.
3. The patient will demonstrate improved lower extremity functional scale score to at least 65/80 in order to return to all prior functional activities

including: driving, caring for children, and completing household tasks (cleaning, cooking, and laundry).

Diagnosis

According to *The Guide to Physical Therapy Practice,* the patient's MPFL reconstruction diagnosis falls under practice pattern 4I: Impaired Joint Mobility, Motor Function, Muscle Performance, and Range of Motion Associated with Bony or Soft Tissue Surgery[16]. The patient responded well to the physical therapy rehabilitation interventions utilized. She demonstrated satisfactory knowledge and demonstration of her home exercise program (HEP) and was compliant and willing to work hard to achieve her physical therapy goals.

Prognosis

The patient's prognosis was excellent for the stated goals considering her age, motivation, progress in pre-operative physical therapy, work ethic, and absence of contraindications to healing or progression of treatments.

Plan of Care

After evaluating the examination, the patient was believed to benefit from a post-operative physical therapy intervention program. The intervention program involved reducing swelling and pain, and improving lower extremity strength, AROM, balance, endurance, body mechanics and overall gait. Education and prevention of re-injury in the future was a key part of the intervention plan. Therapy session frequency included 3x/week for 4 weeks, tapering down to 2x/week for 1 week, and then 1x/week to discharge. She was informally re-

evaluated each session to document any changes that occurred, as well as her response to the current treatment plan, previous treatment session, and HEP.

CHAPTER III

INTERVENTION

The patient was an overall healthy person, who was highly motivated for physical therapy both before and after MPFL reconstruction. The intervention plan of care was to treat the patient 3x/week and taper down to 2x/week for 6-8 weeks for progression of left knee ROM, strengthening with emphasis on left quadriceps, and improving balance. The treatment program was designed by a student physical therapist with clinical instructor supervision. There was no treatment protocol provided by the physician, with no rotation for 4 weeks being the only restriction. Weeks 1-4 focused on decreasing pain, eliminating swelling, allowing for early incision and tissue healing, gaining AROM and active contraction of quadriceps to begin strengthening. Strengthening and stabilization exercises were utilized for hip, knee, ankle joints, as well as core stabilization exercises. Weeks 4-6 focused on gaining full AROM/PROM, restoring quadriceps strength, and gradually work on increasing functional activity (caring for her children, driving, and completing household tasks such as cleaning, cooking, and laundry) at home and in the community by implementing balance and stability training.

The chosen exercises for pre-operative treatment and post-operative treatment are outlined in daily treatment tables found in appendix C and D. The exercises were based on a study completed by Earl and Hoch et al[17] which

followed a group of 19 women who had patello-femoral pain syndrome by completing an eight-week hip and core strengthening program. After the eight week program was completed, improvements were found in the women's pain levels, functional ability, core strength, endurance, hip abduction, and hip external rotation which in turn also improved knee strength and stability. Many of the exercises were chosen from the Earl and Hoch et al[17] proximal strengthening program along with information from Kisner[18] for knee extensor strengthening with emphasis on VMO strengthening for patellar stability. A home exercise program (HEP) was also implemented.

Initial Visit Post-Op

During the initial visit post-operatively the patient was instructed to begin the HEP she had been completing prior to surgery 2x/day. The HEP included long sitting quadriceps sets using a rolled towel under her left knee, long sitting heel slides within a pain-free range, and 4-way straight leg raises. The number of sets and repetitions for each of the HEP exercises are described in Table 2. Quadriceps sets involved isometric contraction of the quadriceps to push the knee down into the table. Heel slides involved the patient actively sliding her heel up towards her buttock and back down with the assistance of a powder board. Patient was instructed to perform this exercise at home using a smooth surface while wearing a sock to allow ease of motion. The patient tolerated the exercises in the HEP well.

Table 2. HEP Description

Exercise:	Repetitions/Time	Sets
Quad Sets	20	2
Heel Slides	20	2
4 way SLR	15 each	1

Biomechanics of the knee were explained to the patient, as well as how to properly perform all of the exercises in the HEP, including frequency and progression of sets/reps according to her pain levels. The patient was advised to continue icing her knee as needed to control post-operative pain and swelling. Further instruction was given to ice for 10-15 minutes at a time, using a damp towel as a barrier between the ice and her skin to avoid frostbite or sensory damage to her skin.

Weeks 1-4

The patient's ACE™ wrap and dressings were removed by the student physical therapist to inspect the incisions and skin prior to performing circumference measurements of the right and left knees. The patient's gait status was weight bearing as tolerated (WBAT) with pain rated at 10/10; however, her pain was abolished (0/10) with non-weight bearing (NWB). During the first week, the patient performed the exercise program with pain rated as 10/10 with weight bearing activities during the first week and pain decreased to 3/10 by week four. The patient was compliant in HEP completion throughout the first four weeks of the treatment program. Each physical therapy session began with a warm up on the stationary bike for 7 minutes alternating every other minute forward and

backwards pedaling. Quad sets were performed using a towel roll focusing on prolonged isometric holds for active quadriceps contraction. Russian current and neuromuscular electrical stimulation (NMES) techniques were utilized as external stimulation to facilitate quadriceps contraction. The results of a study done by Taradaj et al[19] showed that NMES is effective for muscle training in sport, as they observed an intensive increase of power and mass of quadriceps muscle after one month of therapy. However, experiments in the literature are usually based on small number of participants, with unclear randomization. Two large electrodes were applied to the proximal rectus femoris muscle and the VMO.

Following two sessions of NMES, electrical stimulation was discontinued due to therapeutic exercise having more of an effect on strengthening the quadriceps muscles alone when not combined with treatments of NMES, as noted by the patient's progressions in treatment with and without NMES. There was no change in strength levels after using electrical stimulation only twice. Long arc quads (LAQs) were performed in short sitting on the plinth with orange therabands for resistance. Hamstring curls were performed using an orange theraband for resistance with progression from a seated position to standing. Step-ups (forward, backwards, sideways), and the leg press machine were implemented to progress quadriceps and hip strengthening. Bridging with abduction was implemented using red therabands to strengthen the gluteal musculature. Stool scoots were implemented to strengthen hamstrings. Heel raises in standing were also included in the treatment program in order to strengthen the gastocnemius muscles to provide more stability to the knee joints,

as gastrocnemius is a muscle that crosses the knee joint. A new treatment that was utilized for this patient was strengthening with the Core Stix™ unit. This is a panel that flexible resistive sticks are inserted into that provides resistance while performing exercises for the upper extremities, lower extremities, or spinal musculature. This allows for strengthening and stabilization based upon the position of the sticks and the color of the sticks for increased resistance [20] (see appendix E). With this patient, lower extremity stabilization and strengthening was the goal of using the Core Stix.™ The Core Stix™ unit was utilized for assisted squats progressing to straight leg dead lifts and un-assisted squats. At the end of each treatment, the Game Ready™ [21] vaso-pneumatic compression device was utilized for 15 minutes to control swelling and soreness after treatments, with cold and compression settings set according to the Game Ready™ manual. See appendix D for specific description of daily interventions.

Weeks 4-6

Progressions were made by increasing resistance, repetitions, and duration of treatment with increased demands on the patient for strengthening and stabilization. Resistance was increased on the stationary bike, and treadmill walking was implemented in order to observe and educate the patient on gait and weight bearing, as well as strengthening and endurance components. Exercises that were added to treatment included: balance training on a BOSU™ ball, additional exercises with the Core Stix™ unit, manual therapy for PROM to increase range of left knee flexion and also soft tissue mobilization of scar tissue that formed around incisions utilizing Graston™ tools and techniques in order to

increase AROM. Theraband sidesteps and theraband clamshells were used to strengthen the hip abductors. The leg press was split into sets of single leg and double leg press with weight adjusted according to patient response and ease of movement. Single leg stance was implemented to focus on balance training and intrinsic muscle endurance. See appendix D for specifics on daily interventions. By week 5 the patient had 0/10 pain, and had met all of her goals. The patient was discharged from physical therapy after week 6, and obtained a gym membership at the clinic in order to continue her strengthening program. She was able to return to all prior activities, care for her children, drive safely and independently, and participate in all community and church activities pain-free.

See appendix E for a comparison of protocols focusing on differences in bracing, weight bearing status, strengthening, return to functional activities, crutch use, and ROM progressions in research for MPFL reconstructions. All three protocols were less aggressive than the plan of care implemented with the patient described in this case study. The physical therapy program for the patient in this case study did not have weight bearing restrictions, was out of the brace by week 4, and was introduced to closed kinetic chain (CKC) strengthening exercises by the second and third visit of week 1 post surgery. This patient's brace was never in a locked position, and she was given crutches to use as needed for a duration determined by her which was about 1 week. Return to functional activity (noted as return to sport in the protocols examined) was also significantly greater (up to 4-6 months) in the protocols compared to the 6-8 weeks for the patient described in this case study. A limitation in this comparison

is the non-athlete status of the patient in this case study to other protocols for MPFL reconstruction with athletes looking at return to sport specific functions.

CHAPTER IV

OUTCOMES

The patient was treated by physical therapy prior to MPFL reconstructive surgery 3x/week for 2 weeks (6 visits). Beginning 1 week post-operative MPFL reconstruction, the patient was treated by a student physical therapist over the course of 6 weeks. The patient was treated 3x/week for the first 4 weeks, and 2x/week for the last 2 weeks for a total of 22 visits pre- and post-MPFL reconstruction. The patient had excellent outcomes from the pre- and post-surgical physical therapy she received based on the subjective and objective measurements used to evaluate effectiveness of the intervention plan. Subjective measurements included pain level on 0-10 scale and abilities at home. Objective measurements included gross manual muscle test (MMT) strength measurements, ROM measurements, circumferential measurements, and LEFS scores.

Pre-Operative Outcomes

Left knee AROM measurements were taken each visit using a goniometer. The initial AROM of the right knee equaled 0- 0-135° and the left AROM equaled 0-12-68° with pain and lateral crepitus near end range. The patient progressed to AROM within normal limits (WNL) by the second week with no pain, however, lateral crepitus remained present at 65°. Circumference measurements were not taken during pre-operative physical therapy visits, due to the patient displaying

no visible swelling pre-operatively. Pain levels were recorded each visit using a scale from 0-10 (0=no pain, 10=worst pain possible). The patient's pain level was 5/10 with 60° left knee flexion during week 1. By week 2, her pain level reduced to 3/10 at 60° left knee flexion. Strength was measured using gross muscle testing each week. During the initial examination, the patient displayed 4/5 strength in right lower extremity, and 3/5 strength of left lower extremity. At discharge left lower extremity strength increased to 4/5. The LEFS was administered at the initial evaluation and again at discharge at the end of week 2. At initial the patient's LEFS score was 18/80 (22.5% of maximal function). At week 2 the patient's LEFS score increased to 25/80 (31.25% of maximal function) Table 3 shows the progression of weekly subjective and objective measurements prior to MPFL reconstruction.

Table 3. Progression of subjective and objective measurements, pre-operative

	Week 1		**Week 2**
	Right	Left	Left
AROM	0°-135°	12°-68° lateral crepitus, painful	WNL lateral crepitus
MMT(Strength)	4/5	3/5	4/5 Bilateral
Pain	0/10 at all times	5/10 at 60° flexion	3/10 at 60° flexion
LEFS Score	18/80		25/80
Subjective Report			

At the end of pre-operative physical therapy treatments, the patient had gained full ROM, improved strength to 5/5, and was able to drive independently, care for her children, and complete household tasks including cleaning, cooking,

and laundry. The patient responded well to physical therapy pre-operatively and went into surgery stronger and at a higher and more functional level of mobility. This gave her a higher potential for rehab post-operatively as indicated by a study by Topp et al.[22] This study presented that exercise pre-habilitation including strength and flexibility training before surgery, may result in better functional outcomes after total knee arthroscopy. A study by Tenforde et al[23] looked at the effects of an initial traumatic injury event on the altered biomechanics and the development of post-traumatic osteoarthritis (PTOA). The study concludes that neuromuscular pre-habilitation may be important in restoring and preserving joint function by strengthening appropriate muscle groups, improving joint kinematics, and retraining gait patterns to prevent development of PTOA.

Post-Operative Outcomes

AROM measurements of the knee were taken each visit using a goniometer. Initial AROM of the left knee post-operatively was 10-93° with pain noted at 85° left knee flexion. Right knee AROM was 0-135°. The patient progressed to full PROM in week 5, and full AROM in week 6 with no pain throughout ROM. Circumference measurements were taken each visit until no swelling was present. Significant knee circumference measurements are as follows: right knee circumference measurements 1" below patella was 38 cm; left knee circumference measurements 1" below patella was 38.5 cm. All other circumference measurements remained consistent with initial examination. By week 3, circumference measurements were equal bilaterally at 38cm. Pain levels were recorded each visit using the 0-10 scale. The patient's pain level was very

high (10/10) with weight bearing and activity, and 0/10 at rest. During week 2, pain levels had decreased to 5/10 with weight bearing and activity, and by week 3 pain equaled 3/10 when descending stairs. Pain was abolished with all activities by week 5 and continued to be 0/10 until discharge. Table 4 shows the progression of documented subjective and objective measurements weeks 1-3 post-operatively.

Table 4. Post-operative outcomes, weeks 1-3

	Week 1		**Week 2**	**Week 3**
	Right	*Left*	*Left*	*Left*
AROM & PROM	0°-135° pain-free	10°-93° painful Pain at 85°	5°-105° pain-free, total of 110° pain	0°-115° AROM, 0°-120° PROM
MMT(Strength)	4/5	Deferred	Deferred	Deferred
Pain	0/10 at all times	10/10 with WB & activity 0/10 at rest	5/10 with WB & activity 0/10 resting	3/10 with descending stairs 0/10 at rest
Circumference Measurements	40 cm 38 cm 42 cm 47 cm	40 cm 38.5 cm 42 cm 47 cm	40 cm 38.1 cm 42 cm 47 cm	40 cm 38 cm 42 cm 47 cm
LEFS Score	17/80		33/80	40/80
Subjective Report				Difficulty descending stairs.

Once her pain was decreased the patient was able to complete household tasks, and ambulate with confidence. She began driving during week 4 when she had gained adequate ROM to feel safe and comfortable to drive herself to and

from physical therapy visits. The LEFS was administered at initial, and at the end of each week. Initially her score was 17/80 (21.25% of maximal function). By week 3, her score increased to 40/80, and at discharge she scored 68-80. This score signifies 85% of maximal function; however, using the LEFS had limitations in that it applies to a younger individual or to an athlete with the fast cutting, jumping, sprinting categories which this patient did not do prior to surgery. Following physical therapy treatment, she returned to full prior function with improved strength and stability. Strength was measured with gross muscle testing which illustrated improvements from physical therapy treatment. At the initial examination, the patient had 4/5 strength in the right lower extremity. Left was deferred due to pain and recent surgery. At week 4, left lower extremity strength equaled 4/5 and by discharge strength equaled 5/5 bilaterally. Table 5 shows the continuation of her progression in physical therapy. The patient responded well to physical therapy treatment with rapid progressions compared to some protocols that were researched by the student physical therapist. A protocol by Davies [24] was found to be very conservative only performing passive range of motion for the first few weeks, and not removing the brace for up to 6 weeks.[24] Patient compliance was excellent throughout pre-operative and post-operative physical therapy treatments, and the patient was very motivated to return to prior level of function. The patient met all short term and long term goals, was independent with her HEP after the initial visit, and was able to return to all activities, household tasks, caring for her children, and community activities safely and pain-free. The patient was discharged with stronger and more stable

lower extremities which may help prevent future injuries and preserve joint mobility and health. The patient and her family were very satisfied with the outcomes of physical therapy pre-operatively and post-operatively.

Table 5. Post-operative physical therapy outcomes, weeks 4-6

	Week 4	**Week 5**	**Week 6**
	Left	*Left*	*Left*
AROM & PROM	0°-120° AROM, 0°-125° PROM	130° AROM 0°-135° PROM	0°-135° AROM
MMT(Strength)	4/5 Pain	4/5	5/5 Bilaterally
Pain	3/10 at 125° flexion. Medial knee 3/10 with activity	0/10 with all activities Reports soreness from exercises	0/10 with all activities and ROM
Circumference Measurements	None	None	None
LEFS Score	48/80	59/80	68/80
Subjective Report	Medial Knee pain, scar tissue.	Completes all house hold tasks without difficulty or lasting pain.	

CHAPTER V

DISCUSSION/CONCLUSION

The patient was seen for physical therapy treatment prior to and after having MPFL reconstruction by a student physical therapist. There was no protocol utilized for this patient, the exercise regimen was made by the student physical therapist with the help of the supervising physical therapist. The program consisted of strengthening the knees and hips, and worked on overall stability of the lower extremities and pelvis. After reviewing several advanced and conservative rehabilitation protocols for MPFL reconstruction, this patient progressed much faster than the advanced protocols available.[24, 25, 26] This case study presents a physical therapy treatment program of a specific individual's exercises to attain individualized goals. There is limited literature in support of a best strategy for rehabilitation following MPFL reconstruction

REFLECTIVE PRACTICE

Minor changes would be made in this case study if there was an opportunity to do it again. The LEFS was used for this patient, but I would have used the Knee Injury and Osteoarthritis Outcome Score (KOOS) for a more joint specific profile of function. According to Salavati et al[27] the KOOS is a reliable (Cronbach's alpha: pain=0.91; symptoms=0.75; ADL=0.96; Sport/recreation= 0.86; quality of life = 0.74) and valid assessment tool to measure function in patients with knee involvement. It is time efficient, and easy to administer with no

equipment necessary. This would have been a better way to assess specific parts of her daily function and what needed the most improvement. Patient education was provided on the importance of biomechanical and postural awareness; however a greater focus should have been on the improper loads in lower extremity joints that may possibly lead to development of osteoarthritis later in life.

Limitations of this study would include not knowing the patient's current physiological potential for osteoporosis which may have been a factor in the displaced bone fragment. In further research, it would be ideal to compare and contrast the different surgical techniques as well as the aggressive and conservative rehabilitation protocols for MPFL reconstruction in order to standardize the best protocol to give patients the highest quality of life. It would be beneficial for clinicians to know what method produces the best long term outcomes. The other limitation of this case study is the comparison of a 36 year old patient's rehabilitation protocol and goals for returning to functioning in the community and at home to that of a young athlete with goals of returning to sport specific activities. This may have skewed the results and significance of the protocol used with this patient and the aggressive fast paced rehabilitation after her MPFL reconstruction.

Appendix A. ICF Disease Taxonomy[28]

ICF Disease Taxonomy

L MPFL reconstruction with bone fragment removal after lateral patellar dislocation

Body Structures/Functions (Impairments)

- ↓ Quadriceps strength
- ↓ Knee ROM
- ↓ Balance, endurance, stability
- ↑ Swelling
- ↑ Pain
- Impaired joint mobility

Activities

- **Abilities**
- Ambulates with axillary crutches post-op in public, with knee brace
- **Limitations:**
- ↓ Fx ambulation & gait efficiency
- Bed mobility – pain
- Transfers – pain
- Standing Balance limited
- Ascend/descent stairs
- Unable to drive (↓ ROM)
- ↓ Independence in ADLs

Participation

- **Abilities:**
- Sit to complete ADLs/housekeeping on a stool
- Sitting Activities
- **Limitations:**
- Church/community activities
- Mobility
- Caring for children
- Homemaking

Personal Factors

- **Positive:**
- Very motivated
- Previous TTT for lateral dislocation on R knee, 2001
- Prevention of re-injury
- **Negative:**
- Fear of another dislocation
- Thyroid Dysfunction
- Stress

Contextual Factors ⟷

Environmental Factors

- **Positive:**
- Supportive husband & family
- Deductible has already been met
- **Negative:**
- Stress from recent move to new home, new city
- Stress of husband searching for new job
- Stress of husband's health
- Hx of patellar dislocation

Appendix B. Pre-Operative Interventions

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Nustep	Initial Eval	5 min Level 1.0	5 min Level 1.0	5 min Level 1.0	5 min Level 1.0	5 min Level 1.0
Stationary Bike			5min	5min	5min	5 min
Quad sets		2x30	2x10	1x20	1x20	1x20
SAQ			2x10	1x20	1x20	1x20
LAQ		1x20	Yellow 1x25	Yellow 1x25	Yellow 1x30	Yellow 1x30
Ham curls		1x20	1x20	1x20	1x20	1x20
4 way SLR		1x20	1x25	1x30	1x30	1x30
3 way calf		1x15e	1x15e	1x10e	1x10e	1x10e
Pro-stretch		1x20e	1x20e	1x20e	1x20e	1x20e
Heel slides		1x20(L)	1x20(L)	1x20(L)	1x25(L)	1x25(L)
Wall ball squats				2x15	1x30	1x30
Theraband clam shells		Green 1x20e	Green 2x10e	Green 1x20e	Green 1x20e	
Theraband Sidestep			Yellow 2x1min. <>	Yellow 2x1min <>	Yellow 1x20 <>	
Step ups +			1x15e	1x15e	1x15e	
Leg Press Sgl						10lb/2x15
Leg press Dbl						30lb/2x15
Stool scoots						2x100 ft
RockerBoard						30e <>
SLDL CoreStix						Purple 1x20
Modalities	Vasox15'	Vasox15'	Vasox15'	Vasox15'	Vasox15'	Vasox15'
Education	HEP handout and education provided.	Reviewed HEP. Importance of body mechanics & posture. Higher repetitions with less pain vs. low repetitions with pain.	Reasoning behind strengthening quads. Gait training – importance of balanced walking pattern.	Possible structure causing clicking – use of Ipad.		Talked about progress. Strength & ROM will need to be gained again after surgery.

Appendix C. Post-Operative Interventions 1

Visit #	1	2	3	4	5	6
Stationary Bike (forward/back)	Initial Eval	7 min	7 min	7 min	7 min	5 min
Quad sets		1x30	3x30	3x30	3x30	
LAQ		Or/3x10	Or/3x10	Or/3x20	Or/3x20	Yw/1x15e
Ham curls		Or/3x10	Or/3x10	Or/1x20	Or/1x20	Yw/1x20
4 way SLR		1x20e	1x20e	1x20e	2x20e	1x15e
Heel slides		1x30	2x30	2x30	2x30	2x30
Theraband clams		Or/2x15	Or/2x15	Or/2x20	Or/2x20	Rd/1x15
Step ups +					L5/2x30	L6/2x30
Leg press Dbl			20lb/3x10	20lb/1x30	20lb/1x30	
Stool scoots				<>1 lap		<>1 lap
BOSU Ball						<>1x30
Heel Raise		2x15 floor	2x15	2x15 stairs	2x15 stairs	1x30 stairs
Bridging w/ER Theraband					Rd/3x15	Rd/2x15
CoreStix Squats					Rd/1x15	Rd/1x30
Manual Therapy				PROM 109°	PROM 109°	PROM 120°
Modalities			Vasox15'	Vasox15'	Vasox15'	Vasox15'
					Russ10'	Russ10'
Education	HEP					

Appendix C. Post-Operative Interventions 2

Visit #	7	8	9	10	11
Bike	5' /5.0	3'/10.0	3'/7.0	5'/7.0	4'/10.0
Treadmill	3'/15%	3'/15%	3'/15%		5'/15%
Single leg stance			Ax/3x30"		
LAQ	Yw/1x15e	Yw/1x15e	Yw/2x15e		
Ham curls	Yw/1x15e	Yw/1x15e	Yw/1x15e	20,25lb/5e	
Heel slides	4x15		5x30		
Wall squats (ball)		3x10	3x10		
Theraband clams	Rd/1x30		Rd/1x30		
Theraband Sidestep	Or/<>1lap		Or/<>2laps		
Step ups +	L6/1x2'	L6/1x2'		L6/1x2	
Leg Press Sgl		20lb/3x10	20lb/3x10	20lb/3x10	20lb/3x10
Leg press Dbl		30-50/3x10	30-50/3x10	40-60/3x10	40-60/3/10
Briding w/ER Theraband	Rd/2x15		Rd/1x30		Rd/3x15
CS Assist. Squats	Rd/1x30	Rd/1x30	Rd/2x15		Bl/2x15
CoreStix Squats	Wt/1x10				
Manual Therapy	PROM 120°	PROM 125°	PROM 130°	IASTM scar mob 15'	IASTM scar mob 15'
Modalities	Vasox15'	Vasox15'	Vasox15'	Vasox15'	Vasox15'
	NMESx10'	NMESx10'			
Education					

Appendix C. Post-Operative Interventions 3

Visit #	12	13	14	15	16
Bike	5'/8.0	5'/8.0	5'/8.0	5'/8.0	5'/8.0
Treadmill	8'/+/15%	10'/+/15%	10'/+/15%	10'/+/15%	10'/+/15%
Ham curls	20#/5e	20-30/5e	30-40/10e	40-50/10e	50-60/10e
Heel slides	1x50		1x50		1x50
Leg Press Sgl	10-20lbs /5e	ecc/40lbs /10e	ecc/50lbs /10e	ecc/60lbs /10e	ecc/60lbs /10e
Lunges	1x10	1x10	1x10		
Chair Squats	1x10	1x10	1x15	1x15	
Gait	3 laps	3 laps	4 laps	4 laps	4 laps
Briding w/ER Theraband			Rd/1x30	Rd/1x30	dd/Rd/1x30
CS Assist. Squats	Wt/1x30	Wt/1x30	Wt/1x30	Wt/1x30	Wt/1x30
CoreStix Squats			Wt/1x30	Wt/1x30	Wt/1x30
Manual Therapy	IASTM Scar mobs 10'	IASTM Scar mobs 10'	IASTM Scar mobs 10'		
Education					

Appendix D. Core Stix Resistance Levels[20]

Stick Color:	**Resistance Level:**	**Weight of stick:**
Purple	X-lite: 15 lbs.	2 lbs.
White	Lite: 20 lbs.	3.5 lbs.
Yellow	Medium: 35 lbs.	4 lbs.
Blue	Heavy: 45 lbs.	4.25 lbs.
Red	X-Heavy: 55 lbs.	4.5 lbs.

Appendix E. Comparison of protocols in the literature

Protocol:	ROM:	WB Status:	Brace/Crutch use:	Return to activities:	Begin CKC Strengthening:
Fowler[29] Less conservative	Week 0-1: 0° Week3: 0-90° Week 4: 0-110° Week 5: 0-120° Week 6: Full ROM	**TTWB:** Wk 1-2: 25% Wk 2-3: 50% Wk 3-4: 75% Wk 4-6: 100% WB	Wk 2-4: Brace locked during ambulation. 4-6 wks: DC brace, DC crutches	Wk 6-12: return to sport	Wk 0-4: leg press Wk 4-6: knee ext, minisquats, wall slide SAQ/hams, leg press, step-ups, partial lunges, squats 0-90
Tanner[30] Conservative	week 0-1:0 week 2: week 3: 0-60 week 4: 0-90 0-30 week 5: 0-110 week 6: 0-120 week 8: Full	**TTWB** Wk 0-1: 0% wk 1-2: 25% wk 2-3: 50% wk 3-4: 75% Wk 4-6: 100%	Wk 2-4: unlock brace for WB depending on quad. Control. Wk 4-6: DC crutches	4-6 months: Return to sport	Wk 0-4: Leg press Wk 4-6: Leg press, step ups, partial lunges, sq 0-90
OSU[31]	Wk 0-2: 0-30° wk 2-4: 0-90° Wk 4-6: 0-120° Wk 6-10: Full ROM	WBAT 0-4 weeks	Wk 0-4: brace locked in 0° extension except when sitting Wk 4-6: hinged brace max 0-90° Wk 6-10: DC brace	4-6 months: return to sport	Wk 4-6: calf press, lateral step ups, side-stepping, Wall squats/partial leg press (0-60 o)

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